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BOTANY.[1]

Nitrogen Fixation in Algæ.—The following results of research on this subject since 1892 are thus summarily stated in a recent number of Nature. They are chiefly derived from the papers of Grossowitsch, Schloessing, Laurent and Koch. Their observations shed much light upon the question of the relations exisiting between Algæ, microorganisms, and atmospheric nitrogen. They show:—

(1) That at least two Algæ—Cystococcus and Stichococcus—possess no "fixing" powers in themselves.

(2) That many Algæ, taken together with certain microörganisms of the soil, do possess the power of assimilating atmospheric nitrogen.

(3) That this power is much increased by the addition of such organic substances as sugar.

It should be noticed that among the ten cultures used in the second set of experiments, only two contained definitely isolated algal species, viz. the cases of the two cultures of Cystococcus and soil-bacteria.

It was just in this instance, moreover, that it had been shown that the Alga itself had no capacity for fixing atmospheric nitrogen. Accordingly there could be little doubt that it was through the agency of the microörganisms that the "fixation" had taken place in these latter cultures.

The experiments of Laurent and Schloesing had shown that if in a culture of Algæ and bacteria endowed with "fixing" powers, the Algæ were destroyed, the bacteria lost partly, if not entirely, this capacity, which the mixture had possessed. This pointed clearly to the fact that there was some close relationship existing between the Algæ and microorganisms.

There are many facts which seem to indicate the nature of this relationship.

Berthelot found that the nitrification of the soil only took place as long as organic compounds were present; if these were exhausted, the nitrifying process ceased. Gautier and Dronin also showed the importance which organic compounds have with respect to nitrification. Kossowitsch's own experiments, in which the advantage of adding sugar to the culture was shown, also point in the same direction.

From such observations as these, Kossowitsch concludes that the relationship which the Algæ bear to the microörganisms is one connected with the organic food supply of these latter; he thinks that the Algæ, furnished with nitrogen by the bacteria, assimilate the carbohydrate material, part of which goes to their own maintenance, but part also to that of the microörganisms. It is, therefore, in his belief, an instance of symbiosis in which each supplies the wants of the other. There are many facts, partly the result of his own observations, partly the result of those of others, which uphold this view. If the mixed culture be placed in the light, there is a far more noticeable nitrogen increase than when in darkness. Again, if a rich supply of carbon dioxide gas be provided, this is marked by a decided rise in nitrogen-fixing powers. Both these conditions are such as are known to influence carbohydrate assimilation in chlorophyll-containing organisms; but all experience is antagonistic to the view that light should be beneficial to the vital activity of the bacteria, and there are only one or two exceptional instances (Nitromonas, etc.) in which carbon dioxide can be directly assimilated by these microörganisms.

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[1] Edited by Prof. C. E. Bessey, University of Nebraska, Lincoln, Nebraska.

Moreover, in the cases where the bacteria are bought into immediate contact with the Alga, as in those species of Algæ which are enveloped in a gelatinous covering wherein the microörganisms become imbedded, nitrogen fixation appears to be greatly aided, and the addition of sugar to the culture has no such marked effect as in the instances where non-gelatinous Algæ are employed. The explanation of this seems to be that the bacteria embedded in the gelatinous sheath are amply provided with carbohydrate food without the addition of sugar, which, therefore, comes more or less as a superfluity.

All this seems to justify Kosswitsch's view of the part played by the Algæ in the fixation of nitrogen; it appears to show that they have an indirect, but none the less important, influence upon the process. (Nature, Jan. 24, 1895.)

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*See Proc. Mad. Bot. Cong. 45. Je 1894.

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Examples.

1. **Lagerheim, G. von.** Ueber das Vorkommen von Europæischen Uredineen auf der Hochebene von Quito. Bot. Centralb. **54:** 324–331. 1893.
2. **Trelease, W.** A revision of the American species of Epilobium occurring north of Mexico. Rept. Mo. Bot. Gard. **2:** 69–117. *pl. 1–48.* 22 Ap 1891.
3. **Sargent, C. S.,** Editor. Populus monticola. Gard. and For. **7:** 313. *f. 56.* 8 Ag 1894.

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*Those abbreviations are as follows: Ja, F, Mr, Ap, My, Je, Jl, Ag, S, O, N, D; i. e., the initial of the month followed by the first distinctive letter.

4. **Dietel, P.** Die Gattung Ravenelia. Hedw. **33:** 22–48. *pl. 1–5.* 30 Ja. 49–69. 15 Ap 1894.

The foregoing are correct forms for catalogue by author. The following illustrate cases arising under the rules indicated by the letter preceding.

5. Ell. and Everh. Pyren. 491. My 1892.

6. e. Proc. Phil. Acad. **1894:** 53–59. 1894.

The year number, 1894, is the volume number, and not necessarily the year of publication. E. g.,

7. e. Bessey, Am. Pomol. Soc. **1885:** 42. 1886.

8. e. **Mez, C.** Bromeliaceæ. III. Flora Brasiliensis 115: 425–634. *pl. 81–114.* 1 F 1894.

Not Fasc. CXV, 425-634, t. 81-114.

9. e. **Saccardo, P. A.** Syll. Fung. **7^2:** 481. N 1890.

10. e. j. Bull. Geol. and Nat. Hist. Surv. Minn. 9: 39–42. 2 Mr 1894.

Not 9^2; nor 9 part 2; nor 1894 [part 2].

11. e. j. Linn. Sp. Plant. **6^2:** 125. 1852. [ed. Willd.]

12. e. j. **Gray, A.** Man. Bot. 225. 1890. [6th ed.]

13. f. **Peck, C. F.** Rep. N. Y. Mus. **47:** —(18). N 1894.

14. g. Ell. and Everh. N. A. F. *1642.* F 1889.

15. g. Rept. Mo. Bot. Gard. **2:** 98. *d. pl. 28.* 22 Ap 1891.

16. i. Beringer, Am. Jour. Pharm. **66:** 220. My 1894.—Tulasne, Ann. Sci. Nat. Bot. III. **7:** 85. *d. pl. 2. f. 3.* 1847.

17. j. **Bailey,** The Japanese plums in North America. Bull. Cornell Exp. Sta. 62: 3–36. Ja 1894. [Illust.]

The figures are not numbered.

18. k. Ell. and Kell. Jour. Myc. **1:** 12. *d.* Ja 1885.—(Hedw. **24:** 45 *d.* Je 1885.) Peck, (Grev. **22:** 111. Je 1894.)